

1. A method to solve via poisoning for insulative porous low-k materials comprising the steps of:

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providing a substrate having a first and a second insulative layers separated from each other by an intervening etch-stop layer formed therein said substrate;

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forming a hole opening in said first and second insulative layers, including said intervening etch-stop layer;

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forming a low-k protection layer over said substrate, including in said hole opening;

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forming a trench opening over said hole opening to form a dual damascene structure;

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forming a barrier layer on the vertical walls of said trench opening and on said low-k protection layer on the vertical walls of said hole opening;

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forming a metal layer over said barrier layer in said dual damascene structure; and

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24 performing chemical mechanical polishing (CMP) to complete
the forming dual damascene structure.

2. The method of claim 1, wherein said first insulative
layer is a low-k dielectric having a dielectric constant
3 between about 2.0 to 3.0.

3. The method of claim 1, wherein said first insulative
layer has a thickness between about 2000 to 100000 Å.

4. The method of claim 1, wherein said intervening etch-
stop layer is silicon nitride.

5. The method of claim 1, wherein said intervening etch-
stop layer has a thickness between about 50 to 1000 Å.

6. The method of claim 1, wherein said second insulative
layer is a low-k dielectric having a dielectric constant
3 between about 2.0 to 3.0.

7. The method of claim 1, wherein said second insulative
layer has a thickness between about 2000 to 100000 Å.

8. The method of claim 1, wherein said low-k protection layer comprises SiO₂, SiN, SiC and SiNC.

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9. The method of claim 1, wherein said low-k protection layer has a thickness between about 20 to 1000 Å.

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10. The method of claim 1, wherein said barrier layer comprises Ta, Ti, TaN, TiSiN, TaSiN, WN.

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11. The method of claim 1, wherein said barrier layer has a thickness between about 30 to 500 Å.

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12. The method of claim 1, wherein said metal comprises copper.

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13. A method to solve via poisoning for insulative porous low-k materials comprising the steps of:

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providing a substrate having a passivation layer formed over a first metal layer formed on said substrate;

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forming a first insulative layer over said substrate;

- 9 forming an etch-stop layer over said first insulative layer;
- 12 forming a second insulative layer over said etch-stop layer;
- 15 forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern;
- 18 etching said first and second insulative layers, including said etch-stop layer through said hole pattern to form a
- 21 hole reaching said passivation layer;
- removing said first photoresist mask;
- 24 forming a low-k protection layer over said substrate, including in said hole opening;
- 27 forming a second photoresist layer over said substrate, including said hole opening and patterning said second
- 30 photoresist to form a second photoresist mask having a trench pattern;

33 etching said second insulative layer through said trench
pattern in said second photoresist mask to form a trench in
said second insulative layer, thus completing the forming
36 of said dual damascene structure in said substrate;

removing said second photoresist mask;

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removing said low-k protection layer from over said
substrate and from the bottom of said hole opening and
42 thereby exposing underlying said passivation layer while
leaving said low-k protection layer on the vertical sides
of said hole opening;

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removing said passivation layer from said bottom of said
hole opening, thereby exposing underlying said first metal
48 layer;

forming a barrier layer over said substrate, including in
51 said dual damascene structure;

depositing a second metal over said barrier layer in said
54 dual damascene structure; and

performing chemical mechanical polishing (CMP) to complete
57 the forming of said dual damascene structure.

14.The method of claim 13, wherein said substrate is
silicon.

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15. The method of claim 13, wherein said passivation layer
comprises silicon nitride (SiN).

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16. The method of claim 13, wherein said passivation layer
has a thickness between about 30 to 1000 Å.

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17.The method of claim 13, wherein said first insulative
layer is a low-k dielectric having a dielectric constant
3 between about 2.0 to 3.0.

18.The method of claim 13, wherein said first insulative
layer has a thickness between about 2000 to 100000 Å.

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19.The method of claim 13, wherein said intervening etch-
stop layer is silicon nitride.

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20.The method of claim 13, wherein said intervening etch-
stop layer has a thickness between about 30 to 1000 Å.

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21.The method of claim 13, wherein said second insulative layer is a low-k dielectric having a dielectric constant

3 between about 2.0 to 3.0.

22.The method of claim 13, wherein said second insulative layer has a thickness between about 2000 to 100000 Å.

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23. The method of claim 13, wherein said etching said first and second insulative layers is accomplished with a recipe comprising C₂F₆, C₄F₈, Ar, N₂ and O₂.

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24. The method of claim 13, wherein said etching said etch-stop layer is accomplished with a recipe comprising C₂F₆, C₄F₈, Ar, N₂ and O₂.

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25.The method of claim 13, wherein said low-k protection layer comprises SiO₂, SiN, SiCN and SiC.

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26.The method of claim 13, wherein said low-k protection layer has a thickness between about 30 to 1000 Å.

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27. The method of claim 13, wherein said removing said low-k protection layer is accomplished with a recipe comprising

3 C₂F₆, C₄F₈, Ar, N₂ and O₂.

28. The method of claim 13, wherein said barrier layer comprises Ta, Ti, TaN, TiSiN, TaSiN, WN.

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29. The method of claim 13, wherein said barrier layer has a thickness between about 30 to 500 Å.

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30. The method of claim 13, wherein said second metal comprises copper.

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31. A damascene structure with a protection layer for low-k materials comprising:

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a substrate having a damascene structure with an upper trench opening and a lower hole opening formed in a low-k dielectric layer;

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a low-k protection layer on the vertical walls of said lower hole opening;

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a barrier layer over said low-k protection layer on said

12 vertical walls of said lower hole opening, and on the
vertical walls of said trench opening; and

15 a metal layer deposited in said dual damascene structure.

32. The damascene structure of claim 31, wherein said low-k
dielectric layer comprises black diamond, CVD SiC, SiLK,
3 polymer.

33. The damascene structure of claim 31, wherein said low-k
protection layer comprises SiO₂, SiN, SiC and SiCN.